

Written Amendment
(Amendment based on Section 11)

To Mr. Hiroshi YAMAMURA, Examiner at the Patent Office

1. Identification of the International Application

PCT/JP99/02910

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4. Object of Amendment: Description and Claims

5. Contents of Amendment

- (1) As indicated in the appended sheets, "being composed of two lenses: one positive lens and one negative lens comprising at least one aspherical surface" is added in p.2, line 26 (p.2, line 19 in English).
- (2) As indicated in the appended sheets, "comprising at least one aspherical surface" is added in p.3, line 1 (p.2, line 20).
- (3) As indicated in the appended sheets, "during camera shake." in p.3, lines 4-5 (p.2, lines 26) is amended to --during camera shake. The shifting amount Y of the third lens group at a focal length f of an entire system when correcting camera shake, the shifting amount Yt of the third lens group at a telephoto end, and the focal length ft of the telephoto end satisfy the following conditional expressions.

$Y_t > Y$; and

$(Y/Y_t) / (f/f_t) < 1.5$.

- (4) As indicated in the appended sheets, the following contents are added

in p. 3, lines 9-10 (p.2, lines 32):"Furthermore, since the third lens group is composed of two lenses: a positive lens and a negative lens, the aberration when correcting camera shake can be corrected more efficiently, and deterioration of image quality can be decreased even when correcting camera shake. Since the third lens group is composed of at least one aspherical surface, aberration when correcting camera shake can be corrected with further efficiency, and thus, performance when moving the lenses can be improved.

Furthermore, since the fourth lens group comprises at least one aspherical surface, aberration at correcting camera shake can be corrected as well as at a stationary state with further efficiency. In addition to that, deterioration in the optical performance can be prevented when camera shake occurs by satisfying the above-mentioned expressions."

(5) As indicated in the appended sheets, paragraphs in p.3, line 11-p.4, line 15 (p.2, line 33-p.3, line 26), ranging from "In the first zoom lens" to "camera shake occurs." are deleted.

(6) As indicated in the appended sheets, "Preferably" in p.4, line 16 (p.3, line 27) is amended to --Preferably in the first zoom lens--.

(7) As indicated in the appended sheets, "having a positive refracting power" is added in p.5, line 12 (p.4, line 18).

(8) As indicated in the appended sheets, "having a negative refracting power" is added in p.5, line 13 (p.4, line 19).

(9) As indicated in the appended sheets, "and the fourth lens group...or fourth lens group" in p. 5, lines 17-19 (p.4, lines 24-27) is deleted.

(10) As indicated in the appended sheets, "during the camera shake." in p. 5, line 20 (p.4, line 28) is amended to --during camera shake. The third lens group comprises a convex lens having an aspherical surface when viewed from the object side, and a local radius of curvature $rS1$ for a diameter occupying 10% of lens effective diameter and a local radius of curvature $rS9$ for a diameter occupying 90% of lens effective diameter satisfy the following conditional expression.

$0.01 < rS1/rS9 < 2.00$ --.

(11) As indicated in the appended sheets, "when correcting camera shake." in p. 5, line 25 (p.4, line 34) is amended to --when correcting camera shake. In such a zoom lens, long back focus can be secured easily since the fourth lens group includes lenses having a negative refracting power. This is suitable for an optical system of a video camera using three imaging devices, which requires a long back focus. Furthermore, sufficient aberration performance can be obtained by satisfying the above-mentioned conditional expression.--.

(12) As indicated in the appended sheets, “either the third or fourth lens group...during camera shake” in p. 5, line 26-p.6, line 2 (p.4, lines 35-37) is amended to --the third lens group--.

(13) As indicated in the appended sheets, a paragraph in p.6, lines 4-9 (p.5, lines 2-9), “It is also preferable...which requires a long back focus.” is deleted.

(14) As indicated in the appended sheets, paragraphs “Preferably, ...when shifting the lenses.” in p.6, line 14-p.7, line 3 (p.5, lines 14-31) are deleted.

(15) As indicated in the appended sheets, the respective portions of “either the third or fourth lens group...during camera shake” in p.7, lines 4-5 (p.5, lines 32-34), lines 9-10, lines 16-17, lines 21-22 (p.6, lines 1-3, lines 8-10, lines 13-15) are amended to --the third lens group--.

(16) As indicated in the appended sheets, paragraphs from p.7, line 26 to p.9, line 1 (p.6, line 17-p.7, line 9), “Preferably, ...Accordingly, a small zoom lens can be provided.” are deleted.

(17) As indicated in the appended sheets, the following paragraphs are added in p. 9, line 10 (p. 7, line 20):

Next, a third zoom lens of the present invention comprises a first lens group having a positive refracting power and being fixed with respect to an image plane; a second lens group having a negative refracting power and varying power by moving along an optical axis; a third lens group having a positive refracting power, comprising at least one aspherical surface, being composed of at least three lenses including at least one positive lens and at least one negative lens, and being fixed with respect to the image plane; a fourth lens group having a positive refracting power, comprising at least one aspherical surface and moving along an optical axis so as to keep the image plane varied by a shift of the second lens group and an object at a predetermined position from a reference surface. In this zoom lens, the first to the fourth lens groups are disposed from the object side in this order. The entire third lens group is moved vertically with respect to the optical axis so as to correct movement of the image during camera shake. The shifting amount Y of the third lens group at a focal length f of an entire system when correcting camera shake, the shifting amount Y_t of the third lens group at a telephoto end, and the focal length f_t of the telephoto end satisfy the following conditional expressions.

$$Y_t > Y; \text{ and}$$

$$(Y/Y_t) / (f/f_t) < 1.5$$

This type of zoom lens is favorable in downsizing when compared to a zoom lens comprising an optical system for correcting camera shake attached in front of the lens. Since a whole lens group of a united optical performance is decentered,

deterioration in aberration can be decreased when compared to a type of zoom lens where a part of lenses in a group is moved. The third lens group is required to have a strong positive power to decrease the full length in order to obtain a small zoom lens. In this preferable embodiment, aberration occurring at this time can be corrected with the three lenses.

Preferably, the third lens group is composed of at least one aspherical surface. Accordingly, aberration when correcting camera shake can be corrected with further efficiency, and thus, performance when moving the lenses can be improved. Preferably the fourth lens group comprises at least one aspherical surface. Accordingly, aberration when correcting camera shake can be corrected as well as when a stationary state with further efficiency. In addition to that, deterioration in the optical performance can be prevented by satisfying the above-mentioned expressions when camera shake occurs.

It is also preferable that the third lens group includes a positive lens, and a cemented lens of a positive lens and a negative lens. Accordingly, tolerance when assembling a group of correcting lenses can be eased.

Preferably, a focal length f_3 of the third lens group and a focal length f_w of an entire system at a wide-angle end satisfy the following conditional expression.

$$2.0 < f_3/f_w < 4.0$$

Accordingly, the shifting amount when correcting camera shake can be decreased and the zoom lens can be shortened as a whole, and thus, a small zoom lens can be provided.

Preferably, a surface on the object side of a lens disposed closest to the object side in the third lens group is aspherical, and a local radius of curvature R_{10} in the vicinity of an optical axis and a local radius of curvature R_{11} in an outer peripheral portion satisfy the following conditional expression.

$$1.05 < R_{11}/R_{10} < 2.5$$

Accordingly, spherical aberration can be corrected satisfactorily.

Preferably, a surface on the object side of a lens disposed closest to the object side in the fourth lens group is aspherical, and a local radius of curvature R_{20} in the vicinity of an optical axis and a local radius of curvature R_{21} in an outer peripheral portion satisfy the following conditional expression.

$$1.05 < R_{21}/R_{20} < 2.0$$

Accordingly, coma-aberration on the upper flux of the off-axis ray can be corrected favorably.

Preferably, the fourth lens group is composed of one positive lens.

Next, a third video camera of the present invention is characterized in that it includes the above-mentioned third zoom lens. Accordingly, the video camera has a

function to correct camera shake and can be downsized and weight-reduced.

Next, a fourth zoom lens of the present invention comprises a first lens group having a positive refracting power and being fixed with respect to an image plane; a second lens group having a negative refracting power and varying power by moving along an optical axis; a third lens group having a positive refracting power and being fixed with respect to the image plane; a fourth lens group having a negative refracting power and being fixed with respect to the image plane; and a fifth lens group having a positive refracting power and moving along an optical axis so as to keep the image plane varied by a shift of the second lens group and an object at a predetermined position from a reference surface. In this zoom lens, the first to the fifth lens groups are disposed from the object side in this order. The third lens group is moved vertically with respect to the optical axis so as to correct movement of the image during camera shake. The third lens group and the fourth lens group are composed two lenses respectively, and Abbe's number v_{31} of one lens of the third group, Abbe's number v_{32} of the remaining lens of the third group, Abbe's number v_{41} of one lens of the fourth group and Abbe's number v_{42} of the remaining lens of the fourth group satisfy the following conditional expressions.

$$|v_{31}-v_{32}|>25$$

$$|v_{41}-v_{42}|>25$$

Since such a zoom lens can provide a sufficient achromatic effect, deterioration in magnification chromatic aberration can be decreased even when shifting the lenses.

Next, a fifth zoom lens of the present invention comprises a first lens group having a positive refracting power and being fixed with respect to an image plane; a second lens group having a negative refracting power and varying power by moving along an optical axis; a third lens group having a positive refracting power and being fixed with respect to the image plane; a fourth lens group having a negative refracting power and being fixed with respect to the image plane; and a fifth lens group having a positive refracting power and moving along an optical axis so as to keep the image plane varied by a shift of the second lens group and an object at a predetermined position from a reference surface. In this zoom lens, the first to the fifth lens groups are disposed from the object side in this order. The third lens group is moved vertically with respect to the optical axis so as to correct movement of the image during camera shake. A focal length f_3 of the third lens group and a focal length f_{34} of a composite focal length of the third and fourth lens groups satisfy the following conditional expression.

$$0.40 < |f_3/f_{34}| < 0.85$$

Since such a zoom lens satisfying the above expression can control the power of the correcting lenses, deterioration in the aberration performance can be prevented and

moreover, degree of lens movement when correcting camera shake can be controlled. Therefore, the lens can be made smaller, and this is favorable for downsizing.

Next, a sixth zoom lens of the present invention comprises a first lens group having a positive refracting power and being fixed with respect to an image plane; a second lens group having a negative refracting power and varying power by moving along an optical axis; a third lens group having a positive refracting power and being fixed with respect to the image plane; a fourth lens group having a negative refracting power and being fixed with respect to the image plane; and a fifth lens group having a positive refracting power and moving along an optical axis so as to keep the image plane varied by a shift of the second lens group and an object at a predetermined position from a reference surface. In this zoom lens, the first to the fifth lens groups are disposed from the object side in this order. The third lens group is moved vertically with respect to the optical axis so as to correct movement of the image during camera shake. A focal length f_w of an entire system at the wide-angle end and a distance BF between the final surface of the lens and the image plane in the air satisfy the following conditional expression.

$$2.0 < BF < 5.0$$

Accordingly, a zoom lens with a long back focus can be provided.

Next, a seventh zoom lens of the present invention comprises a first lens group having a positive refracting power and being fixed with respect to an image plane; a second lens group having a negative refracting power and varying power by moving along an optical axis; a third lens group having a positive refracting power and being fixed with respect to the image plane; a fourth lens group having a negative refracting power and being fixed with respect to the image plane; and a fifth lens group having a positive refracting power and moving along an optical axis so as to keep the image plane varied by a shift of the second lens group and an object at a predetermined position from a reference surface. In this zoom lens, the first to the fifth lens groups are disposed from the object side in this order. The third lens group is moved vertically with respect to the optical axis so as to correct movement of the image during camera shake. A focal length f_w of an entire system at the wide-angle end, focal length f_i ($i=1-5$) of the i -th lens group, and a composite focal length f_{34} of the third and fourth lens groups satisfy the following expressions.

$$5.0 < f_1/f_w < 8.0$$

$$0.5 < |f_2|/f_w < 1.6$$

$$4.0 < f_{34}/f_w < 9.5$$

$$2.0 < f_5/f_w < 5.0$$

Accordingly, a small zoom lens can be provided.

Next, a fourth video camera of the present invention is characterized in that it comprises any one of the fourth to seventh zoom lenses. Accordingly, a small video camera with high-performance and a function to correct camera shake is obtainable.

(18) As indicated in the appended sheets, "...during camera shake." in claim 13 is amended to --during camera shake, and the third lens group comprises a convex lens having an aspherical surface when viewed from the object side, and a local radius of curvature $rS1$ for a diameter occupying 10% of a lens effective diameter and a local radius of curvature $rS9$ for a diameter occupying 90% of a lens effective diameter satisfy the following conditional expression

$$0.01 < rS1/rS9 < 2.00. --$$

(19) As indicated in the appended sheets, claims 19, 24-27 are cancelled.

(20) As indicated in the appended sheets, "any one of claims 13, 14, 16, 17, 19, 20, 21, 22, 23, 24, 25, 26, 27 or 28" in claim 29 is amended to --any one of claims 13, 14, 16, 17, 20, 21, 22, 23 or 28--.

(21) As indicated in the appended sheets, claims 36-41 are newly added.

6. List of appended documents

New sheets 2, 2/1, 3, 4, 5, 6, 7, 9, 9/1, 9/2, 9/3, 9/4, 9/5, Description

New sheets 128, 129, 130, 131, 131/1, 131/2, 131/3, Claims